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Free Response: 3 questions, 52 points, 30 minutes

1. **A survey of physicians in 1979 found that some doctors give a placebo to patients who complain of pain for which the physician can find no cause. If the patients' pain improves, these doctors conclude that it had no physical basis. The medical researchers who conducted the survey claimed that these doctors do not understand the *placebo effect*. Why?** (15 points)

   Answer
   Physical symptoms can improve with a placebo as well as with a real treatment; improvement alone isn't evidence that there's no physical problem. In the absence of a control group, there's no way to know to what extent the placebo effect is causing the improvement or how much more improvement there might be with a real treatment.

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2. Advertisements claim that taking an SAT preparation course can significantly improve performance on the SAT. Assume there are three SAT preparation services available for students to enroll in, and assume you have 200 students available to use in your experiment. Explain the design of an experiment to examine the claim that SAT preparation courses improve SAT scores and, if the claim is correct, determine which of the preparation services would seem to be the best. (15 points)

Answer
Randomly assign the 200 students to 4 groups of 50 students each. Three of the groups will take the SAT preparation courses (each group will take only one course); the fourth group will act as a control group. At the end of the preparation courses, have all 200 students take the SAT. Statistically compare the results of the four groups. You're interested in comparing the SAT prep course scores with the control group to see if the courses have an effect and comparing the SAT prep course scores against each other to see which has the most effect.

Note: Key points that have to be here: Randomization, creation of a control group.

3. You know that a certain trait occurs in 30% of the population. You want to know how many individuals you have to draw from the population, on average, to get three subjects with the trait.

A. Describe how you would use a table of random numbers to do a simulation of this situation. (11 points)

Answer
Let 0,1,2 be "successes," and 3,4,5,6,7,8,9 be "failures." Begin moving through the table looking for successes and count the number of trials it takes to get three successes. Repeat this enough times that you get a sense of the average number of trials required.

Other answers may be possible; accept any reasonable and well-justified answer that successfully simulates the situation in the question.

B. Use the table of random numbers below to carry out five repetitions in the simulation method you described in (A) above. Mark the table so that it's clear to the reader how you did the simulation. Begin with the first element of the first row. If it's necessary to continue on past the first row, start at the beginning of each row. Based on your five simulations, what's your best guess as to the number of trials required to achieve three successes? (11 points)

26411 94292 06340 97762 37033 85968 94165 46514
80011 09937 57195 33906 94831 10056 42211 65491
92813 87503 63494 71379 76550 45984 05481 50830

Answer
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The brackets indicate the number of trials to achieve the three successes. The number of trials are 5, 6, 12, 19, 3. Our best guess based on this would be an average of the five scores, or 9 trials. Note the extreme variability; we would probably want to do several more simulations before we would have much confidence in our estimate. If a student sees this as a geometric waiting time problem, it would take 3.33333 trials on average per success, or 10 trials for three successes. Despite the variability, the estimate of 9 trials is pretty close.

Other answers may be possible; accept any reasonable and well-justified answer that successfully simulates the situation in the question.

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